DOCUMENT RESUME

ED 047 296 AL 002 738

AUTHOR Ehri, Linnea C.
TITLE Sentence Learning in Children and Adults: The Production of Forms and Transforms.
PUB DATE Feb 71
NOTE 15p.; Paper presented at the Annual Meeting of the American Educational Research Association, New York, N.Y., Feb 1971

EDRS PRICE EDRS Price MF-$0.65 HC-$3.29
DESCRIPTORS *Adult Learning, *Age Differences, *Child Language, Deep Structure, Learning Processes, Memory, Nominals, *Psycholinguistics, Recall (Psychological), *Sentences, Statistical Analysis, Surface Structure

ABSTRACT

This investigation was intended to study the effects of some linguistic variables on child and adult memories for sentences when recall was prompted by nouns embedded in the sentences. Its purpose was to examine for developmental differences in sentence processing systems expected by psycholinguistic theory and research. A group of 64 subjects, comprised of fifth graders and college students, were tested individually with 32 sentences of mixed types including active and passive transformations. Recall of both verbatim and synonymous sentences was scored. Results revealed various surface and deep structure differences in the recall patterns of children and adults, suggesting some differences in the factors governing their sentence productions. (Author/FWB)

ED 047296

Sentence Learning in Children and Adults: The Production of Forms and Transforms[1]

Linnea C. Ehri

University of California, Davis

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

This investigation was intended to study the effects of some linguistic variables on child and adult memories for sentences when recall was prompted by nouns embedded in the sentences. Its purpose was to examine for developmental differences in sentence processing systems expected by psycholinguistic theory and research.

Fifth graders and college students (N = 64) were tested individually with 32 sentences of mixed types including active and passive transformations. Recall of both verbatim and synonymous sentences was scored.

Results revealed various surface and deep structure differences in the recall patterns of children and adults, suggesting some differences in the factors governing their sentence productions.

AL 002 788

[1]Paper presented at the Annual Meeting of the American Educational Research Association, New York, N. Y., Feb. 1971.

Sentence Learning in Children and Adults:

The Production of Forms and Transforms

Linnea C. Ehri

University of California, Davis

Imagine yourself seated in front of a tape recorder. You are listening intently to a series of syntactically varied, semantically unrelated sentences, because you know that soon you will be asked to recall on cue each of those sentences. What are you doing? That is, what processes describe how you are able to comprehend, store, and subsequently retrieve from memory those sentences? Furthermore, how do your activities differ from those of a child engaged in the same task? These are the questions which prompted a rather sizeable investigation of sentence learning in children and adults. The present paper is intended to discuss part of this study, that dealing with some differences in performance as a function of age.

In an analysis of sentence learning, several levels of processing appear to be involved at each phase of the task. In order to comprehend utterances, a listener must be able to analyze the constituents of a variety of surface structures, transform them to deep structures where the underlying grammatical relations are identified, and perform appropriate semantic interpretations. Then, in order to produce utterances which are comprehensible and meaningful, a speaker must be able to in some sense reverse the above process. That is, he must be able to analyze the grammatical relations, tense, mode, aspect, etc. inherent in his idea, select contentives, and derive a surface structure which appropriately expresses these deep structure components and relations. Then, if the learner is required to remember as well as to comprehend and produce previously heard sentences, he needs a coding system which preserves relevant syntactic and semantic information in memory. These are aspects of the sentence learning process suggested by recent psycholinguistic theory and research. In order to become facile in the use of

such a multifaceted system, it is probable that substantial linguistic experience is required. The present study is intended to determine whether by the age of ten, children are as proficient as adults in the use of their grammatical competence to perform successfully such operations in a sentence learning task.

Previous studies have indicated that deep structure rather than surface structure characteristics exert a greater influence upon subjects' long-term memories for sentences. Blumenthal (1967), Blumenthal and Boakes (1967), and Davidson (1969) have shown that not the position of nouns in sentences but rather their grammatical function in the deep structure predicts the ease with which adults can recall sentences prompted by these nouns. Davidson and Dollinger (1969) performed a similar experiment with second graders and came to the same conclusions. However, Bever (1968) suggests that, because their linguistic systems lack complete maturity, children may be more susceptible to aspects of the surface structure than adults, and they may not be as facile at organizing verbal input by deep structure rules and at recognizing transformationally equivalent sentence forms. Thus, even though children have been shown to store sentences in terms of deep structure relations, it is possible that they are not as adept at this process as adults, especially when given sentences with a variety of surface forms and deep structure relations. The present study is intended to determine whether additional surface structure complexity does interfere more with child than adult memory for the surface and deep structures of sentences.

Mehler (1963) has discussed subjects' memory for grammatical features in terms of the storage of syntactic footnotes. With repeated exposure to sentences, the accuracy of the learner's recall improves, presumably as a consequence of this coding process which enables him to note such semantically irrelevant features as verb voice and word order. It is likely that children possess less elaborate coding devices than adults and so have more difficulty storing these syntactic footnotes. If this is true, then their learning should progress more slowly,

and recall should be less accurate than that of adults.

To obtain evidence for the above hypotheses and predictions, several variables were manipulated in the present study. Two age groups, fifth graders and college students, were utilized. Each group was given five trials to learn a set of 32 sentences. A variety of syntactic types was selected for which active and passive transformations were constructed. These sentences are illustrated in Table 1 where

---

Insert Table 1 about here.

---

it is evident that for each deep structure grammatical relation, there are at least two semantically equivalent surface structures which differ in complexity. However, according to a linguistic theory of case proposed by Fillmore (1968), the deep structure complexity and the grammatical centrality of the nouns in these sentences do not differ.

In addition to age, trials, and verb voice, one other factor was examined, the sentential position of the noun prompt. Half of the time subjects were given nouns appearing first in sentences, and half the time their recall was prompted by final nouns. Both verb voice and noun prompt position are variables which are inherent in a surface structure description of sentences, but are of minimum relevance in the deep structure. Thus, if fifth graders are more sensitive to surface structure variations than adults, one might expect their performance to suffer more when additional surface structure complexities are introduced. Specifically, children but not adults would be expected to recall fewer passive than active sentences since the former are more complex transformationally and contain a greater number of morphemes in the surface structure. And likewise, when presented with noun prompts which occur in final positions, children should have more trouble producing corresponding sentences since final nouns are embedded more deeply in the surface structure than first nouns.

Method

Task. A prompted recall task was utilized. Subjects were asked to learn various types of two-noun sentences so that, when presented with one of the nouns as a prompt, they could produce the rest of the sentence.

Design. Analyses of variance were performed to assess the influence of six independent variables on recall. The variables manipulated were: Age (5th graders vs. adults); Lists (four different sets of 32 sentences); Trials (five test trials each following a study trial); Grammatical relations among noun pairs (A-O vs. A-I vs. O-by-I vs. O-with-I); Verb voice (active vs. passive); and Noun prompt position (first vs. final position in the sentence). All variables but Age and Lists were repeated measures. The factors Grammatical relations, Verb voice, and Noun prompt position were nested within each age level. In addition, Noun prompt position was nested within Verb voice, and Verb voice was nested within Grammatical relations.

Subjects. The sample consisted of 32 fifth graders drawn from an elementary school and 32 paid college students. Eight subjects from each age group were randomly assigned to each of the four List conditions. Because upper-middle-class children were sampled, one can assume that IQs were comparable and so any resulting differences are more likely a function of age than of intelligence.

Materials. Sentences were constructed so that the two nouns were equally central grammatically according to the linguistic case theory proposed by Fillmore (1968). The nouns served as either agentive, objective or instrumental cases. In sentences where three noun cases were implied in the deep structure and required in the surface structure, a personal pronoun was used to mark the third case slot. (See Table 1 for examples of sentences types.) Active and passive transformations corresponding to each grammatical relation were included on the list of mixed sentence types presented to each learner. This mixed list feature meant that each learner was exposed to all sentence types. Since semantically equivalent syntactic forms were scattered throughout the list, verbatim recall was made especially difficult.

Procedure. A study-test method was utilized. Sentences and noun prompts were presented on a tape recorder to individual subjects. The task was paced at an 8:10 second rate. Subjects' oral responses were recorded on tape for later transcription. In order to enhance the likelihood that subjects would process all sentences regardless of length or complexity during learning, a buzzer was provided for subjects to press as soon as they had interpreted each sentence.

Results and Discussion

Two scoring criteria were applied to sentence productions: verbatim scoring in which sentences had to be retrieved almost perfectly (minor alterations such as verb tense changes and articles switches were overlooked); and synonymous scoring in which both perfectly recalled and transformationally equivalent sentences were counted. Synonymity here was defined strictly. Unless productions utilized the same content words and conformed to those transformationally equivalent forms specified in the present study (see Table 1), they were ignored. Hypotheses were tested at $p < .01$, and post hoc comparisons were conducted at $p < .05$. In addition to these analyses, sentence productions were examined to determine how and to what extent learners altered the surface structure of the original sentences. Hypotheses regarding these results were tested at $p < .05$.

These analyses represent part of a larger study, not all of which can be included in this discussion of age differences. Thus, only some of the results are selected for presentation. Information regarding the effects of other variables can be obtained from the author.

In order to determine whether subjects successfully completed the comprehension phase of the learning task, a buzzer was provided and learners were told to press it as soon as they had interpreted the meaning of each sentence. Analysis of the average number of buzzer presses for each age group revealed that most of the sentences were understood by most of the subjects on the first study trial, although children appear to have interpreted slightly fewer than adults (mean of 29.8 for

children vs. mean of 31.3 for adults out of a total of 32). To examine whether comprehension differences were significant, a z-test was applied to the proportions of subjects in each age group who failed to press the buzzer at least once on Trial 1. Results indicated that significantly more children than adults fell in this category (i.e., 69% children vs. 38% adults, $z = 2.52$, $p < .05$). Thus, assuming that this measure reflects the ease with which comprehension is accomplished, fifth graders appear to be less facile at extracting deep from surface structures than adults.

Although comprehension appeared more difficult for fifth graders than adults, this difference was not evident in recall following the first study trial. The most surprising finding in the present study was the absence of initial differences in the performance of children and adults. In the analyses of variance, although Age emerged as a significant main effect, with $F(1, 28) = 17.44$, $p < .01$ for verbatim scoring, and $F(1, 28) = 15.76$, $p < .01$ for synonymous scoring, Age interacted with Trials, with $F(4, 112) = 25.50$, $p < .01$ for verbatim scoring and $F(4, 112) = 18.94$, $p < .01$ for synonymous scoring. Figure 1 depicts performance for each age group

---

Insert Figure 1 about here.

---

over trials. It is evident that adults did not surpass children in their ability to recall sentences until Trial 2. In fact, children performed slightly but non-significantly better than adults on the first trial. These findings conflict with theoretical expectations suggesting that children are less facile in all respects in their processing of sentences. Rather children appear to be limited in their capacity to improve their memory for sentences when exposed to the forms a number of times. Perhaps adults do possess more elaborate linguistic coding systems which enable them to discriminate and record in memory finer syntactic distinctions, but use of this requires repeated exposure to the sentences being coded. Such a system does not appear to function initially. Perhaps this is because engagement of such a system requires remembering test trial productions, matching them to sentences

heard on the next study trial, inserting corrections, and then remembering the revised version on the next test trial. The possibility that fifth graders are less skilled in this respect is further suggested by a comparison of verbatim and synonymous recall curves for each age group. Whereas differences between verbatim and synonymous recall for adults appear to be declining by Trial 5, verbatim-synonymous differences are increasing over trials for children. Thus, the latter group is not becoming more accurate in its verbatim productions relative to its synonymous productions. Footnote storage is progressing very slowly if at all by the fifth trial.

The absence of initial adult-child recall differences is puzzling when compared to other studies. Although they required subjects to recall nouns rather than sentences, and they used different syntactic forms, Suzuki (1970) and Suzuki and Rohwer (1968) have consistently found adult recall to be superior to fifth grader recall throughout learning. The discrepancy between these studies and the present study does not appear to be a consequence of task or dependent measure differences, since the same absence of Trial 1 differences was found in the present study when nouns were scored and when subjects were asked to recall only nouns. Thus, this finding remains a mystery.

In the analyses of effects of the factors Verb voice and Noun prompt position, child-adult differences were determined by nesting the variables within each age group and comparing the patterns of verbatim and synonymous recall. Differences in the absolute values of recall scores were ignored, since adults were expected to do better in their general recall over trials.

Examination of the effects of Verb voice revealed that this factor exerted a more marked effect on the verbatim recall of children than adults. As expected, fifth graders had more trouble reproducing passive sentences accurately than producing their active counterparts. These results are displayed in Table 2

Insert Table 2 about here.

---

where it can be seen that active-passive differences were significant for three of the four grammatical forms in the verbatim recall of children while only one active-passive difference was significant in adult recall ($p < .01$). Thus, children appear to be less able or inclined to produce complex surface forms than adults. This differential tendency is evident also in a comparison of the total number of active and passive sentences produced by each age group. Whereas adults generated a very similar number of active and passives throughout learning (average of 51 actives and 55 passives), children generated several more actives than passives (average of 52 actives and 38 passives). Thus, one reason children found it more difficult to recall passive sentences accurately was that their tendency to produce active forms interfered with their verbatim recall. However, children were not less able to comprehend passives than actives and to store the underlying ideas. This is demonstrated by the results of recall scored synonymously. Table 2 shows that verb voice exerted no differential effect upon the recall of underlying ideas for either age group. For all but one especially complex pair of active and passive forms, both children and adults were able to remember the deep structures of active sentences as well as passive sentences. Thus, although children differ from adults in their sentence production patterns, they do not differ from adults in their comprehension patterns.

One other variable was included in the present study in an effort to expose age differences in sensitivity to surface structure. The variable, Noun prompt position, was expected to differantially influence child more than adult productions of surface forms since children are presumably more dependent upon word order in generating sentences. However, in none of the analyses was the first noun found to facilitate greater recall than the final noun. That is, neither age group found it easier to produce sentences when given a noun located at the beginning of the sentence. This was true for both verbatim and synonymous recall ($p > .01$). The total absence of any differences indicates that both children and adults can retrieve

with equal ease both the deep and surface structures of sentences when their memories are jogged by either first or final nouns. The function of the noun prompt is not to elicit a chain of words previously heard but rather to arouse the underlying memory unit stored in a non-ordered form. Once the deep structure is retrieved, then a syntactic mechanism operates to derive the surface structure and to organize the words into a sequence.

The foregoing description of sentence retrieval processes asserts the existence of an abstract generative syntactic mechanism of the sort suggested by Lashley (1951) and by transformational psycholinguists. The present study was intended to inquire whether children could be said to possess syntactic mechanisms which are less transformationally agile than adults. If this assertion is correct, then children would be expected to generate fewer transformations in their sentence productions than adults. Results indicate that this was not the case. In fact, the average number of transformations produced by fifth graders ($\overline{X} = 28.3$) was slightly but non-significantly greater than the average number produced by adults ($\overline{X} = 25.3$), with $t_{31} = 1.31$, $p > .05$. These results suggest that children are not less attuned to the correspondence between surface and deep structures and the underlying equivalences of varied surface forms. If anything, they are perhaps more oblivious to non-semantic alterations in the surface structure as evidenced by the fact that they were less able to remember these variations than adults.

In summary, although fifth graders were found to differ from adults in certain respects in their learning of sentences, these differences were not completely consistent with theoretical expectations. Although children failed to comprehend as many sentences as adults during the first study trial, they did not recall fewer sentences than adults on the first test. Adult-child differences did emerge, however, on later trials and this appears to be a consequence of adult superiority in the storage of syntactic footnotes, a task which requires repeated exposure to and practice in the production of sentences. Verb voice differentially affected verbatim

recall of children more than adults. That is, children found the reproduction of passive sentences more difficult than active sentences while adults for the most part did not. That this age difference is a function of surface structure production tendencies rather than deep structure semantic capacities is suggested by the disappearance of age differences when synonymous forms were scored. These results indicate that although children are less likely to produce complex transformations than adults, they can process and store active and passive sentences with equal ease, just as adults can. Whereas age differences in verb voice effects were apparent in the verbatim recall of sentences, noun prompt position had absolutely no effect on recall of any sort. These results reveal that the position of the noun prompt, that is, the depth of its embedding in the surface structure of a sentence, has little bearing on whether fifth graders or adults can recall and produce that sentence. Thus, differential sensitivity to surface and deep structures appears to be doubtful as a description of linguistic differences between fifth graders and adults.

REFERENCES

Bever, T. G., Associations to stimulus-response theories of language. In T. R. Dixon and D. L. Horton, (Eds.), Verbal behavior and general behavior theory. New Jersey: Prentice-Hall, Inc., 1968, pp. 478-494.

Blumenthal, A. Prompted recall of sentences. Journal of Verbal Learning and Verbal Behavior, 1967, 6, 203-206.

Blumenthal, A. and Boakes, R. Prompted recall of sentences. Journal of Verbal Learning and Verbal Behavior, 1967, 4, 674-676.

Davidson, R. E. Transitional errors and deep structure differences. Psychonomic Science, 1969, 14 (6), 293-294.

Davidson, R. E. and Dollinger, L. E. The syntactic facilitation of paired-associate learning: Deep structure variations. Journal of Educational Psychology, 1969, 60 (6), 434-438.

Lashley, K. S. The problem of serial order in behavior. In L. A. Jeffress, (Ed.), Cerebral mechanisms in behavior. New York: Wiley and Sons, Inc., 1951, pp. 112-136.

Suzuki, Nancy. Deep structure and retrieval time in noun-pair learning. Paper presented at Annual Meeting, American Educational Research Association, Minneapolis, Minnesota, 1970.

Suzuki, Nancy and Rohwer, W. D. Jr. Deep structure in the noun-pair learning of children and adults. Child Development, 1969, 40 (3), 911-919.

Table 1

Description of Sentences*

DEEP STRUCTURE CASE RELATIONS BETWEEN NOUNS	SURFACE STRUCTURE	EXAMPLES
Agentive-Objective (A-O forms)	A - active verb - O	The soldier destroys the bridge.
	O - passive verb - by A	The bridge is destroyed by the soldier.
Agentive-Instrumental (A-I forms)	A - active verb - pronoun O - with I	The soldier destroys it with the bomb.
	Pronoun O - passive verb - with I - by A	It is destroyed with the bomb by the soldier.
Objective-by-Instrumental (O-by-I forms)	I - active verb - O	The bomb destroys the bridge.
	O - passive verb - by I	The bridge is destroyed by the bomb.
Objective-with Instrumental (O-with-I forms)	Pronoun A - active verb - O - with I	He destroys the bridge with the bomb.
	O - passive verb - with I	The bridge is destroyed with the bomb.

*In the synonymous scoring criteria applied to sentence productions, the following were regarded as transformationally equivalent forms:

Active A-O < = > Passive A-O
Active A-I < = > Passive A-I
Active O-by-I < = > Passive O-by-I < = > Active O-with-I < = > Passive O-with-I

Thus, two surface structures were available for expression of A-O and A-I forms while four surface structures could be used for O-I forms.

Table 2

Mean Number of Sentences Recalled by Adults and Fifth Graders as a Function of Verb Voice and Grammatical Form (maximum = 4)

DEPENDENT MEASURE	VOICE	ADULTS GRAMMATICAL FORM				FIFTH GRADERS GRAMMATICAL FORM			
		A-O	A-I	O-by-I	O-wi-I	A-O	A-I	O-by-I	O-wi-I
Verbatim Sentences	Active	2.72	2.28	1.96	1.80	2.44	1.86	1.96	1.46
	Passive	2.36	1.58	1.72	1.68	1.28	.60	1.62	.92
	Difference	.36	.70**	.24	.12	1.16**	1.26**	.34	.54**
Verbatim & Synonymous Sentences	Active	2.96	2.52	2.78	2.66	2.60	1.92	2.62	2.38
	Passive	2.96	2.18	2.74	2.84	2.36	.94	2.56	2.48
	Difference	.00	.34**	.04	-.18	.24	.98**	.06	-.10
Synonymous Transforms*	Active	.24	.24	.82	.86	.16	.06	.66	.92
	Passive	.60	.60	1.02	1.16	1.08	.34	.94	1.56
	Difference	-.36	-.36	-.20	-.30	-.92	-.28	-.28	-.64

*Values represent gains in recall occurring when synonymous as well as verbatim sentences were scored. Tests of significance were not performed for these differences.

**$p < .01$

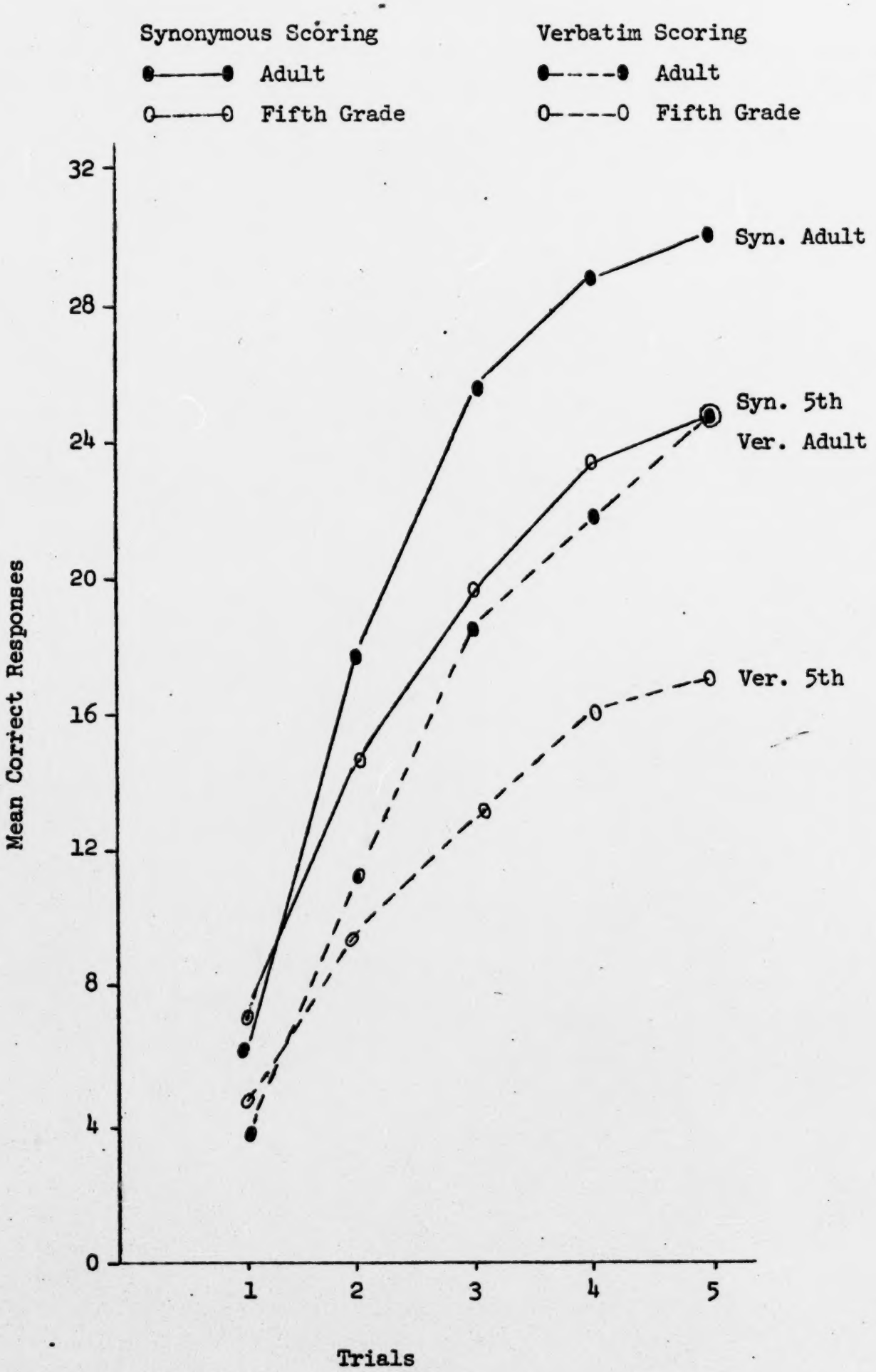

Fig. 1 Mean number of sentences recalled as a function of age, trials, and scoring criteria (maximum = 32)